isolated barometric observation, whether above or below the normal, *has no value whatever* and becomes useful only when taken in reference to others.

As a last and quite secondary remark, may I point out that the example of reduction of wind velocity selected by Professor McAdie could not be more unfortunately chosen. Every one who has to deal with velocities of that order knows that 60 miles per hour is equivalent to 88 feet per second, and it does not require any time or labor to see that 6 miles per hour is 8.8 feet per second. I am no expert and very poor at mental arithmetic, yet I can, in the twinkling of an eye, reduce the decimal to inches and decimals without pencil and paper, since (to illustrate the mental process followed),

$$\frac{8}{10} \text{ feet} = \frac{8\times 12}{10} \text{ inches} = \frac{96}{10} \text{ inches, or 9.6 inches,}$$

so that the speed is 8 feet 9.6 inches per second; but 8.8 feet is much preferable. Of course it is easy to select cases where this reduction is not so readily made. I think the chief objection to stating the velocity of wind in miles per hour, at any rate when the wind pressure is concerned, is that the latter being expressed in pounds per square foot, the same expression contains *two different* units of length, namely, the foot and the mile, being therefore irrational.

ADOPT THE KELVIN THERMOMETER SCALE AND THE METRIC SYSTEM.

By HENRY HELM CLAYTON. Dated Blue Hill, Mass., February 12, 1909.

I have read with interest the suggestions made by Prof. A. G. McAdie in the MONTHLY WEATHER REVIEW for November, 1908, p. 372. I wish very much that our Weather Bureau could see a way to adopt the metric system; but I believe it would be a misfortune if it should also adopt with it the centigrade thermometer scale. This scale is poorly adapted to meteorological work. In our climate [New England] nearly half the readings would be above and half below 0° C. This would be a constant source of confusion and mistakes. Each time the temperature fell below zero the observer would need to invert his method of reading. The normal method of estimating subdivisions in a vertical scale is to read the whole number on the scale and estimate the tenths upward. Thus if the thermometer reads 1.2° below zero the tendency is to read the 2° on the scale [next below the top of the mercury column] and estimate the tenths upward [to the top of the mercury column], thus making the reading —2.8° instead of —1.2° as it should be in reading downward. My experience convinces me that mistakes of this kind are not uncommon. Again it is confusing and a source of error to have two sets of values only distinguishable from each other by the presence or absence of a minus sign.

It is not uncommon to see in newspapers where matter must be printed hurriedly, and even sometimes in books, a temperature given without the minus sign. Thus a temperature of fifteen degrees below zero may be printed as 15° without the minus sign, hence, giving an entirely erroneous idea of its value. With the adoption of the centigrade scale the Bureau would need to be constantly on its guard against such errors. Again with half the values in a column of figures plus and half minus the addition for the purpose of obtaining means is very troublesome and would undoubtedly increase the time and cost of the work.

Hence I am led to renew a suggestion which I made ten years ago in Nature[1] namely that when the metric system comes into use by the English-speaking peoples, as it must in time, the Kelvin thermometer scale be adopted with it instead of the centigrade scale.

In the Kelvin scale the freezing point of water is 273° and the boiling point is 373°. It is a scale based on well-ascertained physical phenomena such as the rate of expansion of gases, the conductivity of metals, etc. It is a scale which enters into many of the mathematical formulas used in meteorology and it is a scale which is coming more and more into use for recording very low temperatures such as the freezing points of air and of hydrogen. So that if the centigrade scale were adopted there would still be two scales in use.

The only serious objection that I can see to the adoption of the Kelvin thermometric scale, is the increased number of figures required in recording and printing meteorological observations. But this is not so great as it appears. Printed columns of figures in degrees centigrade must, as a rule, reserve room for the printing of three figures to the left of the decimal point. It takes as much time and room to write —15° C. as it does to write the equivalent 258° K.

The adoption of the Kelvin scale with the metric system has already been recommended by a committee of the British Association (June, 1904) and if it should be adopted by the U. S. Weather Bureau either alone or in agreement with the English Meteorological Office, it would undoubtedly come into general use and become a universal scale, forever free from the troublesome below zero values.

[1] Nature, September 21, 1899, 60:491.

EXPRESS ALL BAROMETRIC MEASUREMENTS BY ORDINARY GENERAL UNITS OF FORCE.[1]

By Prof. Dr. W. KOEPPEN, Hamburg. Dated February 7, 1909.

[Translated by C. ABBE, jr., April, 1909.]

In the MONTHLY WEATHER REVIEW for November, 1908, Prof. A. G. McAdie, the well-known official in charge of the California Section of the U. S. Weather Service, makes a very noteworthy proposal. He recommends that the Weather Bureau should, as soon as possible, adopt the centigrade (not Celsius) scale and the metric system in measuring temperature, wind, rain, and snow; but he goes further and suggests that the Bureau should cut loose from the accident of the employment of mercury in the barometer and adopt as unity the mean standard pressure of 760 mm.=29.92 inches, calling it 1,000 for convenience sake.

The unification of the measures and scales of the meteorological world, through the adoption of the metric and centigrade systems by England and America, as suggested by Professor McAdie, is an advance most heartily to be desired. So extensive an observing system can not, however, be expected to change its present scales until persuaded of the perfect fitness and adaptation of that which is to be substituted. And it is not to be denied that our mode of expressing air pressure is still deficient in these lines.

Professor McAdie's proposal to adopt the pressure of 760 millimeters (which is already used in this sense as "one atmosphere") as the unit in all pressure measurements, would indeed bring about an undeniable advance were it not that this particular "normal pressure" or "Normaldruck" is a wholly conventional value. As is well known, the average barometric pressure even at sea level is very different for different places. Even this adopted value of 760 millimeters is only related to the metric system through a new quantity, the density of mercury. If this latter be eliminated, then the value 760 millimeters signifies a pressure of 1033.291 grams on 1 square centimeter if the gram is regarded as a unit of force. Physicists, however, recognize that it is more rational to conceive of the gram as a unit of mass, rather than a unit of force, and to take as unit of force the product gram × acceleration of gravity, i. e., value of 980.65 centimeters which is for latitude 45° at sea level. Thus a barometric reading of 760 millimeters, under normal gravity, corresponds in the C. G. S. system to 1,013,303 units. One

[1] Published simultaneously in Met. Zeitschr., May, 1909, 26:198–201.

million such units would correspond to a barometer at 750.1 millimeters. One may use this value as a unit calling it "one small atmosphere," or, with Bjerknes and Sandström,[2] 1 *Bar.* Then 1 *decibar* represents the pressure of a layer of distilled water at its maximum density and under standard gravity, 0.98 meter deep, or 1 megadyne per square centimeter.[3] A *millibar* is almost $\frac{3}{4}$, or more exactly 0.75006 millimeter mercury. The abreviations for these terms are naturally b., db., cb., mb.,[4] in agreement with the other abreviations of the metric system.

Starting with the customary assumption of 760 millimeters for the average pressure at sea level, we find the new pressure unit of 1,000 *mb* (or 750.1 millimeters) at an altitude of 106 meters above sea level.

The question as to whether or not the meteorologist should adopt this new higher level instead of sea level as a plane of reference to which to reduce the observations, is quite independent of the question as to the introduction of this new pressure scale. However, there are many considerations which are in favor of such a change, e. g., the average sea level altitude of the German stations in the Weather Report (Wetterberichte) of the Seewarte is exactly 107 meters (omitting the summit stations whose pressures are not reduced to sea level in these reports); 17 of these stations lie below 100 meters, Frankfurt a/M is 103 meters, and only 11 are above 106 meters. Similar conditions prevail, on the average, over the rest of Europe and in the eastern half of North America. Thus the new plane of reference would lie above the majority of stations, and the calculated, reduced pressure would have a real meaning, whereas at present the plane of reference lies in the earth below all the stations where "atmospheric pressure" means merely *a calculated value*, and the temperature used in making the reduction to sea level has no real existence. In the case of the remaining stations (those that still lie above the new reference plane) the distortions resulting from the reduction are at least lessened; indeed we may well regret that the level of the pressure unit did not happen to fall somewhat higher yet, for the pressure distribution at a level several hundred meters above the earth's surface is a much truer expression of atmospheric conditions than is the pressure at the surface itself. Indeed the lower air masses of the low-lying plains [of northern Germany] are in large part dragged along with the higher masses, i. e., they receive their impulses to motion chiefly from air masses descending from some height, since the friction and resistance at the surface is too great.

Already the desire has been frequently expressed that barometric readings should be reduced to a somewhat higher plane than that of sea level. It could not be realized because there has been small prospect of a general agreement upon some wholly arbitrary plane. The above proposed level is not altogether arbitrary, since it is as truly *the average plane of the unit of air pressure* as is 760 millimeters the mean pressure [measure] at sea level. Since the choice of this latter figure may vary within rather wide limits, one is also at liberty to choose, for the sake of convenience, an even hundred meters instead of 106 meters as the vertical interval up to this new plane of reference.

One of the chief purposes of Professor McAdie's proposal has to do with the general public. He states that the public would then acquire more easily an idea as to the pressure conditions than now, when at present the figure "760" seems to be wholly arbitrary; we may well add that it must seem all the more arbitrary since most people know only the aneroid "barometer" and never associate mercury with the instrument. If, however, the business man reads, for example, 1009, he understands at once without calculating that the pressure is 0.009 above its normal value.

It must not be forgotten, however, that this is only true for barometer readings which are reduced to sea level. If the pressures of our weather reports were reduced to 106 meters or 100 meters above sea level the advantage claimed by McAdie would also pertain to them should my proposal be adopted; while for direct readings to which no corrections have been applied numerically or graphically either method is extremely inaccurate, McAdie's method being better for stations below 50 meters altitude, and mine better for places above 50 meters altitude. If, however, the readings are corrected then it makes but little difference whether the number 1000 or some larger one is used for comparison. In any case, it seems to me that this matter is of small significance in comparison with the advantages to be derived from a rational scale adapted to both scientific and technical purposes.

The following table gives the equivalents of the proposed units, in the units now in use. It is very seldom that the pressures at sea level fall outside the limits of the range of 100 *bar.*, from 950 *mb.* to 1,050 *mb.*

Inches.	Mm.	Mb.	Inches.	Mm.	Mb.
5.91	150.0	200.0	29.53	750 06	1000 0
11.81	300.0	400 0	29.92	760.00	1013.3
17.72	450.0	600 0	31.01	787.60	1050.0
23.62	600 0	800.0	31 89	810.10	1080.0
28.05	712.5	950.0			

It is not probable that those countries which already measure atmospheric pressure in millimeters will change their present system without a strong external stimulus. The advantages of the new system over the existing ones are not pronounced strongly enough for this, and there will be no inclination to lightly overturn the comprehensive unification [of methods] that has finally been accomplished [by international conventions], neither will the inconveniences of the transition period be incurred without some compelling reason. However, should the countries employing the English scales advance in this direction and should there be a well-founded prospect that by accepting this proposal a unification of the meteorological scales of the whole world might be accomplished, then the countries using the metric system would probably be glad to undergo the inconveniences of such a change, regarding them as the price paid for such a great advance. But such could only happen in case a really rational uniform system be offered, it would probably be impossible to secure general agreement to a purely empirical aid.

This reform need be carried out, at first only within meteorology itself. The technologist as well as the physicist and chemist would also probably soon use it because of the many advantages which the new system would offer him, but this can be left to time and meteorology does not need to delay adopting the change until a general agreement among all these branches of science has been secured.

[2] Beiträge z. Phys. d. fr. Atmosph., Strassburg, 1906, 2:1. Also Sandström and Helland-Hansen, Report on Norwegian Fish. and Marine Investig., 1902, 2, No. 4, p. 15; and Knudsen in Bul. trimest. Internat. Comm. f. Meersf., 1906–7, No. 1, p. 41, No. 2, Pl. 14; and elsewhere.

[3] For the physical geographer it would be convenient to adopt as the unit pressure the pressure of a column of water 1 meter high, i. e., to call the acceleration of gravity at latitude 45°=1000 instead of 981; but one would then depart from the strict C. G. S. system. Therefore the Scandinavian scholars, in their oceanographic studies, use the "dynamic meter" of about 1.02 meters length; and thus they express pressure, friction, and the terrestrial deflecting force in terms of the same rational unit.

[4] In the article in the Beiträge, referred to above, *mmbar* is mistakenly used for *mbar* or *mb*.

METEOROLOGICAL REGISTRATIONS IN SAMOA, 1902-1906. I. WINDS.

By Dr. OTTO TETENS, Ph. D. Dated Berne, Switzerland, January 15, 1909.

In the September, 1908, number of the MONTHLY WEATHER REVIEW Mr. C. Fitzhugh Talman gives a short illustrated notice of the Samoa Observatory, which is under the auspices of the Royal Society of Sciences at Göttingen. The volume referred